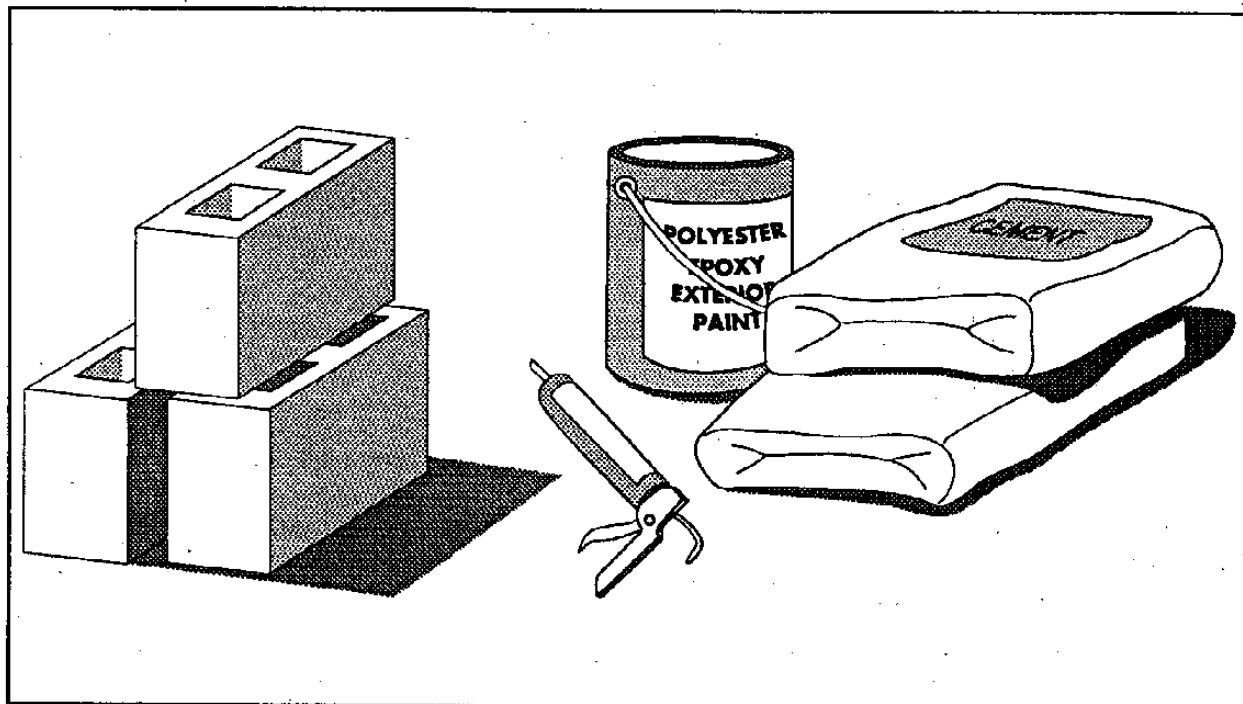


**NOTICE:** Arizona State Law requires that lowest floors be constructed a minimum of **one foot** above the Base Flood Elevation (BFE). This differs from the requirement described in this Technical Bulletin.



Technical  
Bulletin  
2-93

## **Flood-Resistant Materials Requirements** for Buildings Located in Special Flood Hazard Areas in accordance with the National Flood Insurance Program



FEDERAL EMERGENCY MANAGEMENT AGENCY  
FEDERAL INSURANCE ADMINISTRATION

FIA-TB-2  
4/93

## Key Word/Subject Index:

This index allows the user to quickly locate key words and subjects in this Technical Bulletin. The Technical Bulletin User's Guide (printed separately) provides references to key words and subjects throughout the Technical Bulletins. For definitions of selected terms, refer to the Glossary at the end of this bulletin.

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Any comments on the Technical Bulletins should be directed to:

FEMA/FIA  
Office of Loss Reduction  
Technical Standards Division  
500 C St., SW, Room 417  
Washington, D.C. 20472

Technical Bulletin 2-93 replaces Technical Bulletin 88-2 (draft) "Flood-Resistant Materials."

Graphic design based on the Japanese print *The Great Wave Off Kanagawa*, by Katsushika Hokusai (1760-1849), Asiatic collection, Museum of Fine Arts, Boston.

## TECHNICAL BULLETIN 2-93

### **Flood-Resistant Materials Requirements for Buildings Located In Special Flood Hazard Areas in accordance with the National Flood Insurance Program**

#### **Introduction**

The requirement to use construction and finishing materials that are resistant to flood damage in all new and substantially improved buildings in identified Special Flood Hazard Areas (SFHAs) is an important part of the National Flood Insurance Program's (NFIP's) flood-damage-resistant design and construction standards. A residential building's lowest floor is required to be elevated to or above the base flood elevation (BFE). All construction below the lowest floor is susceptible to flooding and must consist of flood-resistant materials. Uses of enclosed areas below the lowest floor in a residential building are limited to parking, building access, and limited storage—areas that can withstand inundation by floodwater without sustaining significant structural damage.

The purpose of this Technical Bulletin is to provide data and guidance on what constitute "materials resistant to flood damage" and how and when these materials must be used to improve a building's ability to withstand flooding.

#### **NFIP Regulations**

Section 60.3(a)(3) of the NFIP regulations requires that the community:

*"Review all permit applications to determine whether proposed building sites will be reasonably safe from flooding. If a proposed building site is in a floodprone area, all new construction and substantial improvements shall...(ii) be constructed with materials resistant to flood damage..."*

It should be noted that Technical Bulletins provide guidance on the minimum requirements of the NFIP regulations. Community or State requirements that exceed those of the NFIP take precedence. Design professionals should contact the community to determine whether more restrictive local or State regulations apply to the building or site in question. All applicable standards of the State or local building code must also be met for any building in a flood hazard area.

#### **Required Use of Flood-Resistant Materials**

##### **Flood-Resistant Material**

"Flood-resistant material" is defined as any building material capable of withstanding direct and prolonged contact with floodwaters without sustaining significant damage. The term "prolonged contact" means at least 72 hours, and the term "significant damage" means any damage requiring more than low-cost cosmetic repair (such as painting).

As stated previously, **all structural and non-structural building materials at or below the BFE must be flood resistant.** This requirement applies regardless of the expected or historic flood duration. For example, buildings in coastal areas that experience relatively short-duration flooding (generally, flooding with a duration of less than 24 hours) must be constructed with flood-resistant materials below the BFE. As noted in the tables within this bulletin, **only Class 4 and Class 5 materials are acceptable for areas below the BFE in floodprone buildings.**

In some instances, Class 1, 2, and 3 materials may be permitted below the BFE, when specifically required to meet local building code provisions concerning life-safety issues. In below-BFE applications, materials that meet life-safety code requirements and have maximum resistance to damage from flood inundation should be used. This applies to the flood-resistant requirements only. In Zones V, VE, and V1-V30, the installation of such materials may create an obstruction. Because obstructions in V zones could result in structural failure of the building, they represent a life-safety issue and shall therefore take precedence over local building codes. Refer to Technical Bulletin 5, "Free-of Obstruction Requirements," for further information.

### **Lowest Floor**

Under the NFIP, the term "lowest floor" is used to define the lowest level of a building that must be located at or above the BFE as required under Sections 60.3(c)(2) and (3) of the NFIP regulations. The floodplain management regulations, under Section 60.3(c)(5), limit the use of all areas below the lowest floor to parking of vehicles, storage, and building access. These reasonable uses below the BFE are permitted because the amount of damage caused by flooding to these areas can easily be kept to a minimum if design and construction requirements contained in the NFIP regulations are met. Failure to meet the requirements can increase the building's damage potential and result in the application of higher flood insurance premiums. The requirement to use flood-resistant materials means that all interior wall, floor, and ceiling materials located below the BFE be unfinished and resistant to flood damage. This is meant to exclude the use of materials and finishes normally associated with living areas constructed above the BFE.

### **Flood Insurance Implication**

An NFIP flood insurance requirement regarding the use of materials in areas below the BFE must also be considered. Flood insurance will not pay a claim for finishing materials (such as clay floor tiles) located in basements or in enclosed areas below the lowest floor of an elevated building, even if such materials are considered to be flood resistant. The NFIP defines finishing materials as anything beyond basic wall construction.

### **Flood-Resistant Classification of Materials**

The information in this Technical Bulletin is based primarily on the U.S. Army Corps of Engineers (COE) 1992 "Flood Proofing Regulations." The following table (Table 1) classifies building materials according to their ability to resist flood damage.

<b>Table 1 Flood-Resistant Classification of Materials</b>		
<b>N F I P</b>	<b>Class</b>	<b>Class Description</b>
<b>A C C E P T A B L E</b>	<b>5</b>	Highly resistant to floodwater damage. Materials within this class are permitted for partially enclosed or outside uses with essentially unmitigated flood exposure.
	<b>4</b>	Resistant to floodwater damage. Materials within this class may be exposed to and/or submerged in floodwaters in interior spaces and do not require special waterproofing protection.
<b>U N A C C E P T A B L E</b>	<b>3</b>	Resistant to clean water damage. Materials within this class may be submerged in clean water during periods of intentional flooding.
	<b>2</b>	Not resistant to water damage. Materials within this class require essentially dry spaces that may be subject to water vapor and slight seepage.
	<b>1</b>	Not resistant to water damage. Materials within this class require conditions of dryness.

Source: COE 1992 "Floodproofing Regulations"

## **Flooring Materials**

Table 2 lists flooring materials commonly used in construction that fall within the five classes described in Table 1. Not all available construction and finishing materials are listed. For products not listed herein, manufacturers' literature should be reviewed for recommended uses. Such recommendations must be complied with fully. All masonry and wood products used in floodprone buildings must comply with the applicable materials standards of the nationally recognized standards organizations, such as the American Society for Testing and Materials (ASTM), the American Concrete Institute (ACI), and the American Wood Products Association (AWPA).

### **Basis for Classification of Flooring Materials**

The classification of flooring materials is based on their vulnerability to damage from inundation by floodwaters. Class 1, 2, and 3 flooring materials are not acceptable for below-BFE applications for one or more of the following reasons:

- Normal suspended-floor adhesives specified for above-grade use are water soluble or are not resistant to alkali or acid in water, including ground seepage and vapor.
- Flooring materials contain wood and wood products.
- Flooring materials are not resistant to alkali or acid in water.
- Sheet-type floor coverings (linoleum, rubber, and vinyl) restrict evaporation from below.
- Flooring materials are impervious but dimensionally unstable.

<b>Table 2 Flooring Materials Classifications for Flood Resistance</b>					
Types of Flooring Materials	Classes of Flooring				
	Acceptable		Unacceptable		
	5	4	3	2	1
Asphalt Tile <sup>1</sup>					•
With asphaltic adhesives			•		
Carpeting (glued down type)					•
Cement/bituminous, formed-in-place		•			
Cement/latex, formed-in-place		•			
Ceramic tile <sup>1</sup>					•
With acid-and alkali-resistant grout			•		
Chipboard					•
Clay tile	•				
Concrete, precast or in-situ	•				
Concrete tile	•				
Cork					•
Enamel felt-base floor coverings					•
Epoxy, formed-in-place	•				
Linoleum					•
Magnesite (magnesium oxychloride)					•
Mastic felt-base floor covering					•
Mastic flooring, formed-in-place	•				
Polyurethane, formed-in-place	•				
PVA emulsion cement					•
Rubber sheets <sup>1</sup>					•
With chemical-set adhesives <sup>2,3</sup>	•				
Rubber tile <sup>1</sup>					•
With chemical-set adhesives <sup>3</sup>		•			
Silicone floor, formed-in-place	•				

**Table 2 Flooring Materials Classifications for Flood Resistance**

Types of Flooring Materials	Classes of Flooring				
	Acceptable		Unacceptable		
	5	4	3	2	1
Terrazo		•			
Vinyl sheets (homogeneous) <sup>1</sup>					•
With chemical-set adhesives <sup>2,3</sup>	•				
Vinyl tile (homogeneous) <sup>1</sup>					•
With chemical-set adhesives <sup>3</sup>		•			
Vinyl tile or sheets (coated on cork or wood product backings)					•
Vinyl-asbestos tile (semi-flexible vinyl) <sup>1</sup>					•
With asphaltic adhesives		•			
Wood flooring or underlayments					•
Wood composition blocks, laid in cement mortar				•	
Wood composition blocks, dipped and laid in hot pitch or bitumen				•	
Pressure-treated lumber, .40 CCA <sup>4</sup>	•				
Naturally decay-resistant lumber <sup>4,5</sup>	•				

- Notes:
- <sup>1</sup> Using normally specified suspended flooring (i.e., above-grade) adhesives, including sulfite liquor (lignin or "linoleum paste"), rubber/asphaltic dispersions, or "alcohol" type resinous adhesives (culmar, oleoresin)
  - <sup>2</sup> Not permitted as Class 2 flooring
  - <sup>3</sup> E.g., epoxy-polyamide adhesives or latex-hydraulic cement
  - <sup>4</sup> Not in the COE list; added by FEMA
  - <sup>5</sup> Refer to local building code for guidance



## **Wall and Ceiling Materials**

Table 3 lists wall and ceiling materials commonly used in construction that fall within the five classes described in Table 1. Not all available construction and finishing materials are listed. For products not listed herein, manufacturers' literature should be reviewed for recommended uses. Such recommendations must be complied with fully. All masonry and wood products used in floodprone buildings must comply with the applicable materials standards of the nationally recognized standards organizations, such as the American Society for Testing and Materials (ASTM), the American Concrete Institute (ACI), and the American Wood Products Association (AWPA).

### **Basis for Classification of Wall and Ceiling Materials**

The classification of wall and ceiling materials is based on their vulnerability to damage from inundation by floodwaters. Class 1, 2, and 3 wall and ceiling materials are not acceptable for below-BFE applications for one or more of the following reasons:

- Normal adhesives specified for above-grade use are water soluble or are not resistant to alkali or acid in water, including ground seepage and vapor.
- Wall and ceiling material contains wood, wood products, gypsum products, or other material that dissolves or deteriorates, loses structural integrity, or is adversely affected by water.
- Wall or ceiling material is not resistant to alkali or acid in water.
- Wall or ceiling material is impervious but is dimensionally unstable.
- Wall or ceiling materials absorb or retain water excessively after submergence.

**Table 3 Walls and Ceiling Materials Classifications for Flood Resistance**

Types of Wall and Ceiling Materials	Classes of Walls and Ceilings				
	Acceptable		Unacceptable		
	5	4	3	2	1
Asbestos-cement board (and cement board <sup>1)</sup> )	•				
Brick, face or glazed	•				
Common				•	
Cabinets, built-in					
Wood				•	
Metal	•				
Cast stone (in waterproof mortar)	•				
Chalkboards					
Slate, porcelain glass, nucite glass	•				
Cement-asbestos				•	
Composition, painted				•	
Chipboard					•
Exterior sheathing grade				•	
Clay tile					
Structural glazed	•				
Ceramic veneer, ceramic wall tile-mortar set		•			
Ceramic veneer, organic adhesives				•	
Concrete	•				
Concrete block	•				
Corkboard				•	
Doors					
Wood hollow				•	
Wood, lightweight panel construction				•	
Wood, solid				•	
Metal, hollow	•				
Metal, Kalamein				•	

**Table 3 Walls and Ceiling Materials Classifications for Flood Resistance**

Types of Wall and Ceiling Materials	Classes of Walls and Ceilings				
	Acceptable		Unacceptable		
	5	4	3	2	1
Fiberboard panels, vegetable types					
Sheathing grade (asphalt coated or impregnated)				•	
Otherwise					•
Gypsum products					
Gypsum board (including greenboard <sup>1</sup> )				•	
Keene's cement of plaster				•	
Plaster, otherwise, including acoustical				•	
Sheathing panels, exterior grade				•	
Glass (sheets, colored tiles, panels)		•			
Glass blocks	•				
Hardboard					
Tempered, enamel or plastic coated				•	
All other types				•	
Insulation					
Foam or closed-cell types		•			
Batt or blanket types					•
All other types				•	
Metals, non-ferrous (aluminum, copper, or zinc tiles)			•		
Metals, Ferrous	•				
Mineral fiberboard					•
Plastic wall tile (polystyrene, urea formaldehyde, etc.)					
Set in waterproof adhesives, pointed with waterproof grout			•		
Set in water-soluble adhesives				•	

**Table 3 Walls and Ceiling Materials Classifications for Flood Resistance**

Types of Wall and Ceiling Materials	Classes of Walls and Ceilings				
	Acceptable		Unacceptable		
	5	4	3	2	1
Paint					
Polyester-epoxy and other waterproof types		•			
All other types					•
Paperboard					•
Partitions, folding					
Wood, pressure treated, .40 CCA minimum <sup>1</sup> (if not treated, then material is Class 2)	•				
Metal		•			
Fabric-covered					•
Partitions, stationary					
Wood, pressure treated, .40 CCA minimum <sup>1</sup> (if not treated, then material is Class 2)	•				
Metal	•				
Glass, unreinforced		•			
Glass, reinforced		•			
Gypsum, solid or block					•
Rubber, moldings and trim with epoxypolyamide adhesive or latex-hydraulic cement		•			
All other applications					•
Steel, (panels, trim, tile) with waterproof applications	•				
With non-waterproof adhesive				•	
Stone, natural solid or veneer, waterproof grout	•				
Stone, artificial non-absorbent solid or veneer, waterproof grout	•				
All other applications				•	

**Table 3 Walls and Ceiling Materials Classifications for Flood Resistance**

Types of Wall and Ceiling Materials	Classes of Walls and Ceilings				
	Acceptable		Unacceptable		
	5	4	3	2	1
Strawboard					
Exterior grade (asphalt-impregnated kraft paper)				•	
All other types				•	
Wall covering					
Paper, burlap, cloth types					•
Wood					
Solid, standard				•	
Solid, naturally decay-resistant <sup>1,2</sup>	•				
Solid pressure treated, .40 CCA minimum <sup>1</sup>	•				
Plywood					
Marine Grade <sup>1</sup>	•				
Pressure treated, .40 CCA minimum <sup>1</sup>	•				
Exterior grade				•	
Otherwise					•

Note: <sup>1</sup> Not on the COE list; added by FEMA

<sup>2</sup> Refer to local building code for guidance

## Construction Examples

### Flood-Resistant Materials in Buildings in Zones A, AE, A1-A30, AR, A0, and AH

Figure 1 illustrates a building elevated on solid foundation walls, over a crawlspace. The NFIP regulations require that the lowest floor be at or above the BFE. The construction method illustrated in Figure 1 meets this requirement. Note, however, that the flooring materials and supporting wood members are at or below the BFE. Therefore, in Figure 1, all materials supporting the lowest floor, including the flooring itself, must be made of flood-resistant materials.

To maximize the use of the area below the lowest floor, it is a common floodplain construction technique to elevate a building a full story (approximately 8 feet), even though the BFE may only be 4 or 5 feet above grade. In such cases, while the NFIP regulations require that Class 4 or 5 building materials be used below the BFE, FEMA strongly recommends that Class 4 or Class 5 materials also be used for the construction of the remainder of the building below the lowest floor. Flood damage from a greater-than-design flood event will thereby be reduced in the lower area.

### Flood-Resistant Materials in Buildings in Zones V, VE, and V1-V30

All structural and non-structural materials installed below the BFE must be flood resistant. The NFIP regulations require that the bottom of the lowest horizontal structural member of the lowest floor (usually the floor beam or girder) of a building in Zone V, VE, or V1-V30 be at or above the BFE. Therefore, all materials below the floor beam(s) must be flood resistant. This includes but is not limited to breakaway wall materials and open latticework. Breakaway walls will remain in place during low-level floods and must be flood resistant, so that they will not deteriorate over time after being soaked by floodwaters. Figure 2, on the next page, illustrates this requirement.

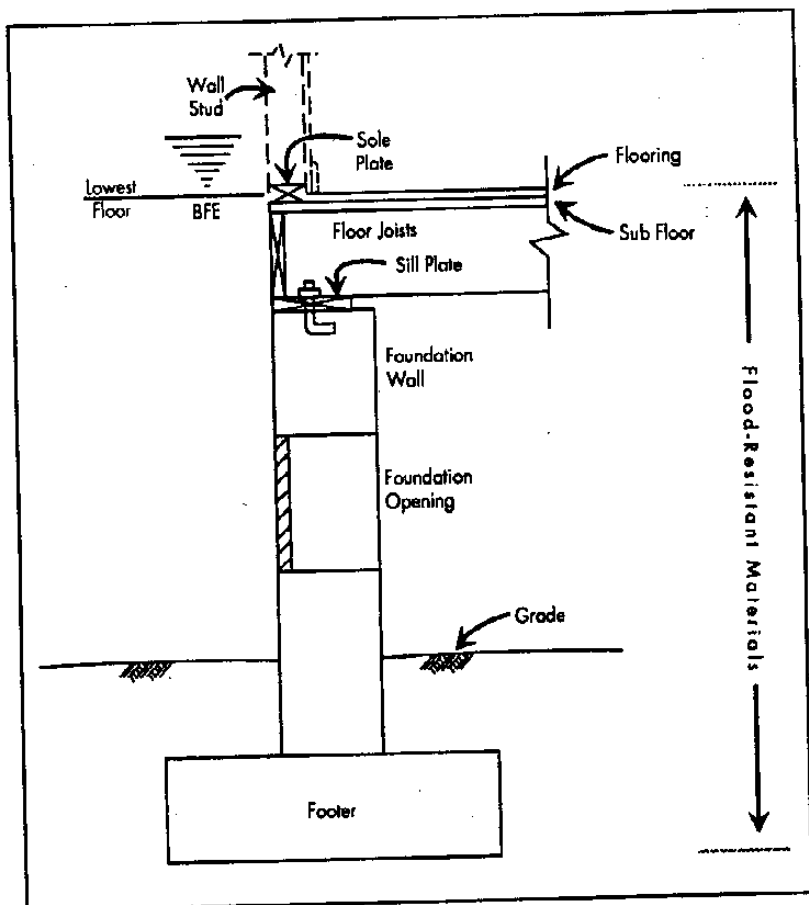


Figure 1. Building Elevated on Solid Foundation Walls Meeting the Minimum NFIP Requirements for Zones A, AE, A1-A30, AR, A0, and AH

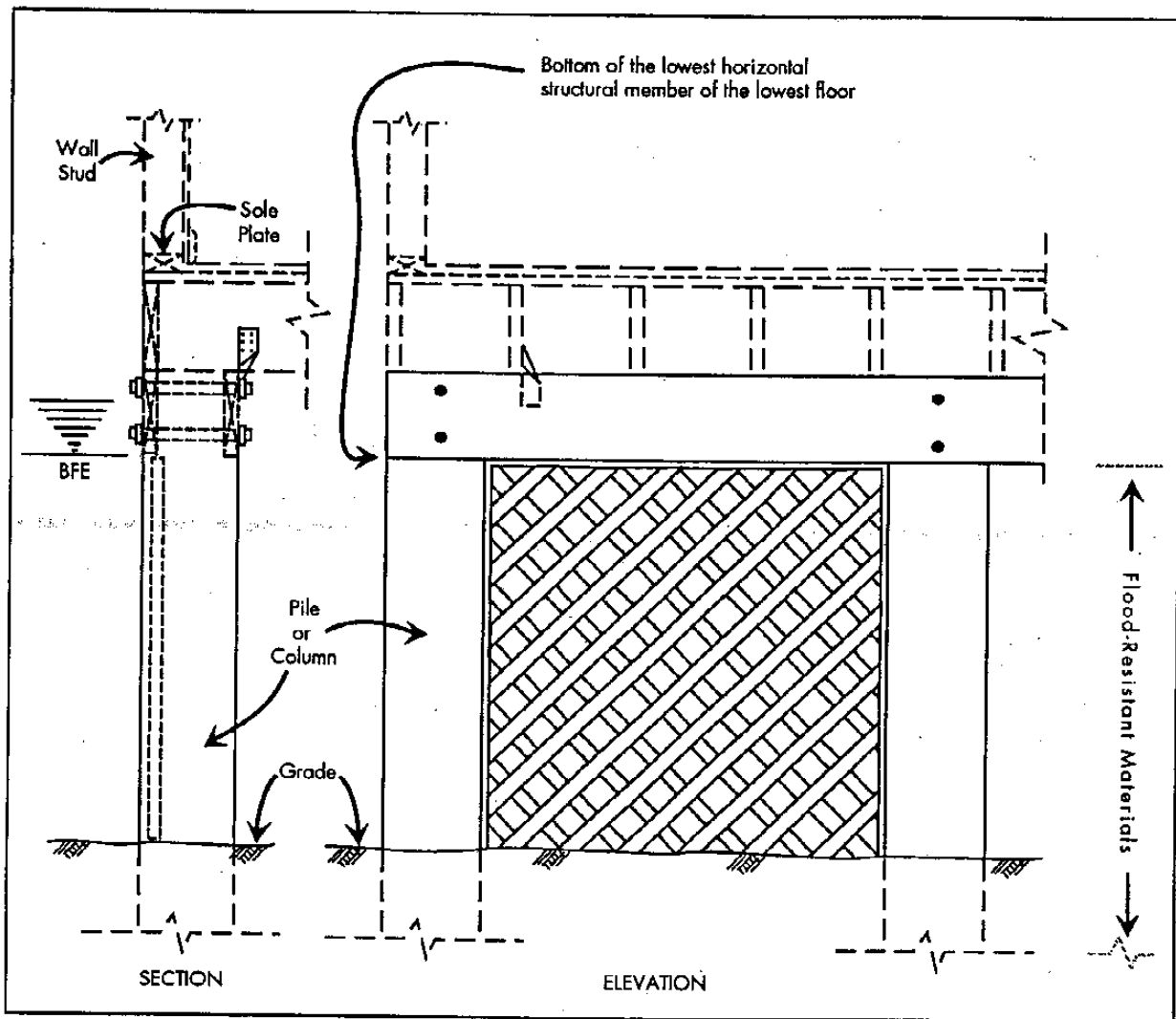


Figure 2. Flood-Resistant Material Requirements for Buildings Elevated in Accordance with NFIP Requirements for Zones V, VE, and V1-V30

## Accessory Buildings

Some communities permit the construction of low-cost, small detached accessory buildings (e.g., garages, storage sheds) with a lowest floor elevation below the BFE (Technical Bulletin 5, "Free-of-Obstruction Requirements," provides definitions of "low-cost" and "small"). The below-BFE portions of such buildings must be constructed of flood-resistant materials so that flood damage will be minimized. Additional construction requirements for these buildings, such as the need to anchor the building to resist flotation, collapse, and lateral movement, also must be met before the building is permitted and built. For additional information about these requirements, contact the community that has permitting jurisdiction.

## Wet Floodproofing

Wet floodproofing is designing a building to allow floodwaters to enter in order to equalize hydrostatic forces. The NFIP does not allow wet floodproofing in lieu of meeting the lowest

floor elevation requirements. However, in situations where the NFIP regulations do not apply, such as voluntary floodproofing of an existing (Pre-FIRM) building not in association with substantial improvements, the use of flood-resistant materials is advisable. Using flood-resistant materials will make cleanup and repair following a flood much easier and less costly than if the floodprone areas are constructed of non-flood-resistant materials.

## **The NFIP**

The NFIP was created by Congress in 1968 to provide federally backed flood insurance coverage, because flood insurance was generally unavailable from private insurance companies. The NFIP is also intended to reduce future flood losses by identifying floodprone areas and ensuring that new development in these areas is adequately protected from flood damage. The NFIP is based on an agreement between the federal government and participating communities that have been identified as floodprone. FEMA, through the Federal Insurance Administration (FIA), makes flood insurance available to the residents of a participating community provided that the community adopts and enforces adequate floodplain management regulations that meet the minimum NFIP requirements. The NFIP encourages communities to adopt floodplain management ordinances that exceed the minimum NFIP criteria. Included in the NFIP requirements, found under Title 44 of the U.S. Code of the Federal Regulations, are minimum building design and construction standards for buildings located in SFHAs. Through their floodplain management ordinances, communities adopt the NFIP design performance standards for new and substantially improved buildings located in floodprone areas identified on FIA's FIRMs.

## **Technical Bulletins**

This is one of a series of Technical Bulletins FEMA has produced to provide guidance concerning the building performance standards of the NFIP. These standards are contained in Title 44 of the U.S. Code of Federal Regulations at Section 60.3. The bulletins are intended for use primarily by State and local officials responsible for interpreting and enforcing NFIP regulations and by members of the development community, such as design professionals and builders. New bulletins, as well as updates of existing bulletins, are issued periodically, as necessary. The bulletins do not create regulations; rather they provide specific guidance for complying with the minimum requirements of existing NFIP regulations. Users of the Technical Bulletins who need additional guidance concerning NFIP regulatory requirements should contact the Natural Hazards Branch of the appropriate FEMA regional office. The "User's Guide to Technical Bulletins" lists the bulletins issued to date and provides a key word/subject index for the entire series.

## **Ordering Information**

Copies of the Technical Bulletins can be obtained from the appropriate FEMA regional office. Technical Bulletins can also be ordered from the FEMA publications warehouse. Use of FEMA Form 60-8 will result in a more timely delivery from the warehouse — the form can be obtained from FEMA regional offices and your state's Office of Emergency Management. Send publication requests to FEMA Publications, P.O. Box 70274, Washington, D.C. 20024.



## **Further Information**

The following publications provide further information concerning the use of flood-resistant materials:

1. "Answers to Questions About Substantially Damaged Buildings," FEMA, May 1991, FEMA-213.
2. "Floodproofing Non-Residential Structures," FEMA, May 1986, FEMA-102.
3. "Flood Proofing Regulations", Chapters 9 and 10, U.S. Army Corps of Engineers, March 1992, EP 1165-2-314.
4. "Flood Proofing Systems and Techniques," U.S. Army Corps of Engineers, December, 1984.
5. "Repairing Your Flooded Home," FEMA and the American Red Cross, August 1992, FEMA-234, ARC 4477.
6. "Technical Notes for Brick Construction," Brick Institute of America, McLean, Virginia, n.d.

## **Glossary**

**Base flood** — The flood that has a 1-percent probability of being equaled or exceeded in any given year (also referred to as the 100-year flood).

**Base Flood Elevation (BFE)** — The height of the base flood, usually in feet, in relation to the National Geodetic Vertical Datum of 1929 or other datum as specified.

**Basement** — Any area of a building having its floor subgrade (below ground level) on all sides.

**Coastal High Hazard Area** — An area of special flood hazard extending from offshore to the inland limit of a primary frontal dune along an open coast and any other area subject to high-velocity wave action from storms or seismic sources.

**Federal Emergency Management Agency (FEMA)** — The independent federal agency that, in addition to carrying out other activities, oversees the administration of the National Flood Insurance Program.

**Federal Insurance Administration (FIA)** — The component of FEMA directly responsible for administering the National Flood Insurance Program.

**Flood Insurance Rate Map (FIRM)** — The insurance and floodplain management map issued by FEMA that identifies, on the basis of detailed or approximate analyses, areas of 100-year flood hazard in a community.

**Floodprone area** — Any land area susceptible to being inundated by floodwater from any source.

**Lowest floor** — The lowest floor of the lowest enclosed area of a building, including a basement. Any NFIP-compliant unfinished or flood-resistant enclosure useable solely for parking of vehicles, building access, or storage (in an area other than a basement) is not considered a building's lowest floor.

**Special Flood Hazard Area (SFHA)** — Area delineated on a Flood Insurance Rate Map as being subject to inundation by the base flood and designated as Zone A, AE, A1-A30, AR, AO, AH, V, VE, or V1-V30.

**Substantial damage** — Damage of any origin sustained by a structure whereby the cost of restoring the structure to its before-damaged condition would equal or exceed 50 percent of the market value of the structure before the damage occurred.

**Substantial improvement** — Any reconstruction, rehabilitation, addition, or other improvement of a structure, the cost of which equals or exceeds 50 percent of the market value of the structure before the "start of construction" of the improvement. This term includes structures that have incurred "substantial damage," regardless of the actual repair work performed.